UNIT I

INTRODUCTION TO RCM

Module 3

RCM TERMINOLOGY AND CONCEPTS

RCM TERMINOLOGY AND CONCEPTS

Module Preview:

Introductio n

- Introduction
- Failures
- Severity
- Probability of Failure
- Criticality
- Reliability
- Types of Maintenance
- Review and Summary

RCM TERMINOLOGY AND CONCEPTS

Module Objective:

Introduction

This module will introduce basic concepts and terminology used in the RCM process.

RCM TERMINOLOGY AND CONCEPTS

Module Objective:

Introduction

1. Define Failure Terminology:

   Functional Failure

   Potential Failure

   Failure Mode

2. Introduce the concepts of ***Severity***, ***Probability of Failure***, and ***Criticality*** and how they are related.

RCM TERMINOLOGY AND CONCEPTS

Module Objective:

Introduction

3. Introduce the concept of *Reliability*.

4. Define the following maintenance terms:

- ***Scheduled Maintenance***
- ***Unscheduled Maintenance***
- ***Preventive Maintenance***
- ***Corrective Maintenance***
- ***Proactive Maintenance***
- ***Reactive Maintenance***
- ***Condition Monitoring***
- ***Condition Based Maintenance***
- ***Conditional Maintenance***

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FAILURES

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Definitions: **Failure**

1. FAILURE: ***An identifiable deviation from a specified condition that is unsatisfactory to an asset owner or manager.***

RCM recognizes two types of failures:

FUNCTIONAL FAILURE - ***Inability of item to perform a specific function within specified performance limits***

POTENTIAL FAILURE – ***Definable and detectable condition that indicates a functional failure will occur***

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Definitions:

Failure

2. FAILURE MODE - ***A specific physical condition that causes a particular functional failure***

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SEVERITY

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Definition:

Severity

SEVERITY - ***A category assigned to a failure mode based on the impacts of its potential effects***

… qualitative measures used to categorize the potential effects of failures.

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Example:

Severity

Severity Classifications Aircraft Example

CATEGORY I (CATASTROPHIC) • Death or Permanent disability • Destruction of system/equipment • Significant breach of environmental regulation • Damage > $1M	**CATEGORY III (MARGINAL)** • Damage >$10K and < $100K • Degraded ability to perform critical mission • Interrupted operations
CATEGORY II (CRITICAL) • Personal Injury • Inability to perform primary mission • Damage >$100K and < $1M	**CATEGORY IV (MINOR)** • Unscheduled maintenance or repair • Damage <$10K

Note: In some circumstances when an item performs a critical function and no effective back-up is available, loss of function for a defined period of time could be considered critical or catastrophic. These conditions should be added to the severity classifications as appropriate

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Example:

Severity

Severity Classifications Plant Equipment Example

CATEGORY I (CATASTROPHIC) • Death or Severe Injury • Significant Environmental Impact • Loss of availability > 1 week • Damage > $1M	**CATEGORY III (MARGINAL)** • Loss of availability > 4 hrs and < 24 hrs • Damage >$10K and < $100K
CATEGORY II (CRITICAL) • Minor Injury • Loss of availability > 24 hrs and < 7 days • Damage >$100K and < $1M	**CATEGORY IV (MINOR)** • Loss of availability < 4 hrs • Damage <$10K

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PROBABILITY OF FAILURE

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Definition:

Probability of Failure

1. **Probability of failure** : ***The probability that a given failure mode will occur during a defined period.***

2. **Acceptable Probability of Failure (P_{acc}):**

The probability of a given failure mode occurring during a defined period that is acceptable to a program or asset manager.

- **The more severe the consequences, the lower P_{acc} should be**
- **Values may be defined by regulatory organizations or self imposed (by a program or asset manager)**

Values should be documented prior to analysis

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Definition:

Probability of Failure

3. Actual Probability of Failure (P_{act}): ***The predicted or demonstrated probability of a given failure mode occurring during a defined period in the operating environment.***

P_{act} can be measured from in-service data or estimated from statistical failure distributions

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CRITICALITY

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Definition: **Criticality**

CRITICALITY - A prioritization of the combination of failure severity and failure frequency (or probability)

- **Sometimes referred to as Risk**
- **Criticality may be documented qualitatively or quantitatively (Ref: MIL-STD-1629)**
- **Asset managers/Programs may define acceptable criticality limits by use of a Hazard Risk Matrix. (Qualitative Method)**
- **Criticality can be used to set priorities for analysis or define acceptable risk**

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Hazard Risk Matrix:

Criticality

SEVERITY \ FREQUENCY	FREQUENT (A) ≥ 1 per 1,000 Hours	PROBABLE (B) ≥ 1 per 10,000 Hours	OCCASIONAL (C) ≥ 1 per 100,000 Hours	REMOTE (D) ≥ 1 per 1,000,000 Hours	IMPROBABLE (E) < 1 per 1,000,000 Hours
CATASTROPHIC (I) • Death or Permanent disability • Significant Environmental breach • Damage > $1M, Downtime>2 days • Destruction of system/equipment	1 HIGH	2 HIGH	4 HIGH	8 MED	12 ACCEPT
CRITICAL (II) • Personal Injury • Damage >$100K and < $1M • Loss of availability > 24 hrs and < 7 days	3 HIGH	5 HIGH	6 MED	10 LOW	15 ACCEPT
MARGINAL (III) • Damage >$10K and < $10 • Loss of availability > 4 hrs < 24 hrs	7 MED	9 MED	11 LOW	14 ACCEPT	17 ACCEPT
MINOR (IV) • Damage <$10K • Loss of availability < 4 hrs	13 ACCEPT	16 ACCEPT	18 ACCEPT	19 ACCEPT	20 ACCEPT

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RELIABILITY

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Definitions:

Reliability

RELIABILITY - *Probability that an asset will perform its intended function for a specified period of time under specified operating conditions*

Actual Reliability is a function of the asset's design, manufacturing process, usage profile, operating environment, and maintenance program.

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MAINTENANCE TERMS

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Definition:

Types of Maintenance

***PREVENTIVE MAINTENANCE** – actions performed periodically (or continuously) prior to functional failure (or multiple failure/demand requirements for hidden failures) to achieve the desired level of safety and reliability for an item*

… These actions are performed to prevent or reduce consequences of failures.

Due to differences in the way the term Scheduled Maintenance is used, this course will attempt to use the term Preventive Maintenance only

RCM TERMINOLOGY AND CONCEPTS

Definition | **Types of Maintenance**

- ***PROACTIVE MAINTENANCE** – any tasks used to predict or prevent equipment failures.*

  Similar to Preventive Maintenance except that it generally excludes failure finding type tasks. Again, definitions may vary…

RCM TERMINOLOGY AND CONCEPTS

Definition:

Types of Maintenance

- ***CORRECTIVE MAINTENANCE** – repairs or other corrective action taken after a failure has occurred*

For the purposes of this course, the term Unscheduled Maintenance is synonymous with Corrective Maintenance and Reactive Maintenance

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Definition:

Types of Maintenance

- ***CONDITION MONITORING – The use of specialized equipment to measure the condition of equipment.***

Vibration Analysis, Oil Analysis, and Thermography are examples of Condition Monitoring techniques

Predictive Maintenance (PdM) and Prognosis and Health Management (PHM) are usually interchangeable with Condition Monitoring.

RCM TERMINOLOGY AND CONCEPTS

Definition: | **Types of Maintenance**

- ***Condition Based Maintenance** – An equipment maintenance strategy based on measuring the condition of equipment in order to assess whether it will fail during some future period, and then taking appropriate action to avoid the consequences of that failure.*

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Definition:

Types of Maintenance

- ***Conditional or Opportunity Maintenance*** *– Maintenance actions conducted as result of a specific condition, or as a result of specific circumstances or events.*

Examples of Conditional Inspections

- *Hard Landing*
- *Unscheduled disassembly*
- *Power Interruption*
- *Over/Under Voltage*
- *Lightning strike*
- *Over stress*
- *Unscheduled or scheduled shut-down*

RCM TERMINOLOGY AND CONCEPTS

Summary:

Types of Maintenance

RCM determines proper balance of planned and unplanned maintenance, along with "Other Actions", to establish a "Failure Management Strategy"

Preventive Maintenance (PM)

Scheduled Maintenance

Proactive Maintenance

Corrective Maintenance (CM)

Unscheduled Maintenance

Reactive Maintenance

Condition Based Maintenance
Condition Monitoring
Predictive Maintenance
Prognosis Health Management (PHM)
Potential failures

Repairs or corrective actions
Run to failure
Failure has occurred

Preserves required functionality
Reduces unplanned downtime
Requires investment

Fixes failures in unplanned manner
Downtime unpredictable
Addresses only "what's broken"

RCM TERMINOLOGY AND CONCEPTS

Review and Summary

Module Objective

- Introduce the primary terminology and basic concepts used in RCM

Introduction

- Learning Objectives

RCM Terms & Concepts

- Failures
- Severity
- Probability of Failure
- Criticality
- Reliability
- Maintenance Terms

End of Module

up next.....

Unit II Module 1 RCM Process Overview